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Radiolytic H_2 generation in the Earth's crust

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Over thirty geological processes can generate molecular hydrogen (H_2) [1]. Of these, serpentinization, which contributes 55–80% of H_2 emanating from the continental crust, and radiolysis (20–45%), are considered the major pathways [2]. Hence, most commercial research interest is focussed upon serpentinization (water + Fe^{2+} bearing minerals). Radiolytic H_2 (dissociation of water molecules by ionizing radiation) is principally championed in astro-biological circles as an abiotic energy source in the deep biosphere, rather than a commercially exploitable resource [3]. However, radiolytic H_2 has been observed on the North American, African, European and Australian continents, and is predicted to exist on Mars and other rocky celestial bodies [3-9]. Here we review the potential for radiolysis as a H_2 source mechanism and re-evaluate its significance within the natural hydrogen system. While the physical stage – radionuclide decay and particle emission – is well understood, the chemical stages of radiolysis in geological fluids remain less constrained. The varying composition of cations, anions, and short-lived radical species in crustal fluids can significantly influence the yield of radiolytic H_2 [10,11]. Change in H_2 yield may have implications for the deep biosphere as well as natural H_2 exploration. Further research is required to better constrain how crustal fluids dissociate and recombine to produce H_2.

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